Shapes & Interactions Part 1:

Shapes of Molecules: VSEPR & Electron and Molecular Geometries

Shape of Molecules =

What is important about the shapes of molecules?

Cells rely on the shape and charge distribution of molecules to communicate with each other.

Examples: 1) hormones @ receptor cites on the surface of cells

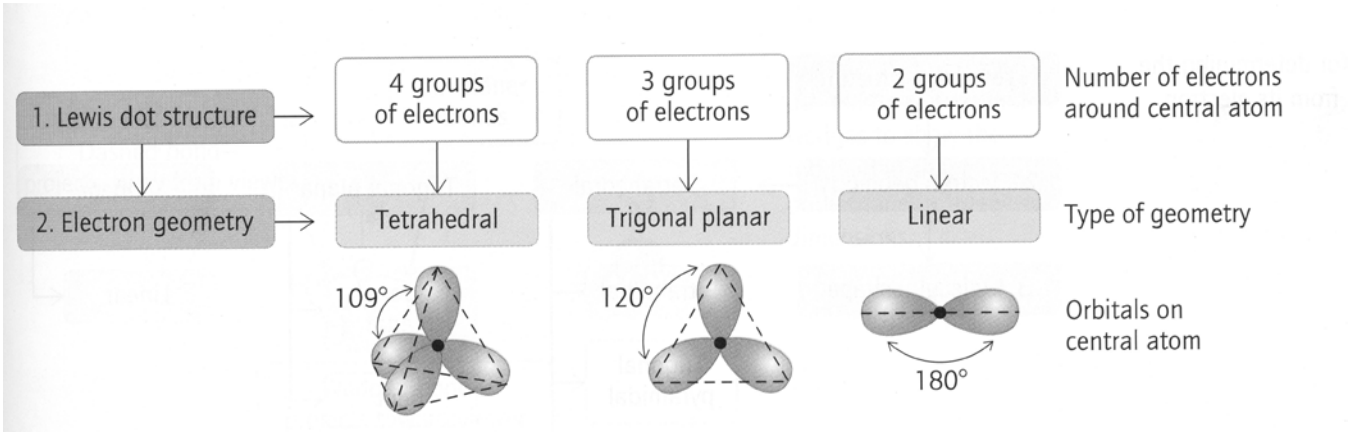
2) drug molecules interact w/ other molecules within cells

Electron Geometry: arrangement of electrons around a central atom

Molecular Shape: arrangement of atoms around a central atom

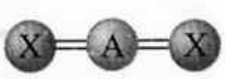
Only 1 Rule: Electrons stay as far apart as possible.

Look at central atom of Lewis Structure to predict electron geometry:

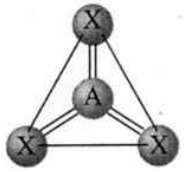
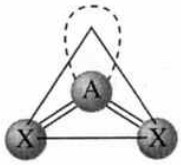


Electron Geometry vs Molecular Shape

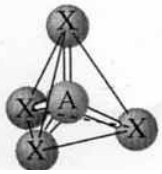
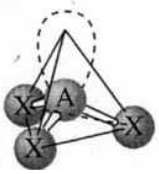
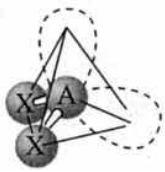
2 Groups of electrons = Linear Electron Geometry – 180° bond angles

	Two double bonds 	One triple bond and one single bond 
Molecular Shape	Linear	Linear

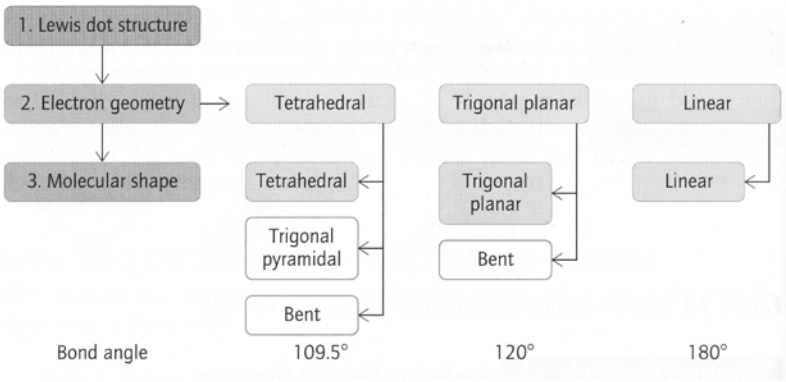
3 Groups of electrons = Trigonal Planar Electron Geometry – 120° bond angles

	One double bond and two single bonds 	One double bond, one single bond, and one nonbonding pair 
Molecular Shape	Trigonal planar	Bent or Angular

4 Groups of electrons = Tetrahedral Electron Geometry – 109° bond angles

	Four single bonds 	Three single bonds and one nonbonding pair 	Two single bonds and two nonbonding pairs 
Molecular Shape	Tetrahedral	Trigonal pyramidal	Bent or Angular

Electron Geometry determines Molecular Shape



How to predict the electron geometry and molecular shape.

1) Start with Lewis Structures.
2) Look at the number of electron groups to determine the e^- geometry.
3) If there are no lone pairs around the central atom, then the molecular shape = e^- geometry
4) Lone pairs around the central atom will create variations to the molecular geometry.

Remember: e^- geometry determines bond angles

Compound	Lewis Structure	Electron Geometry	Molecular Shape	Bond Angle
PH_3				
CH_2O				

Shapes & Interactions Part 2: Electronegativity & Molecular Polarity

Covalent Bonding – a closer look

Are e⁻'s shared equally?

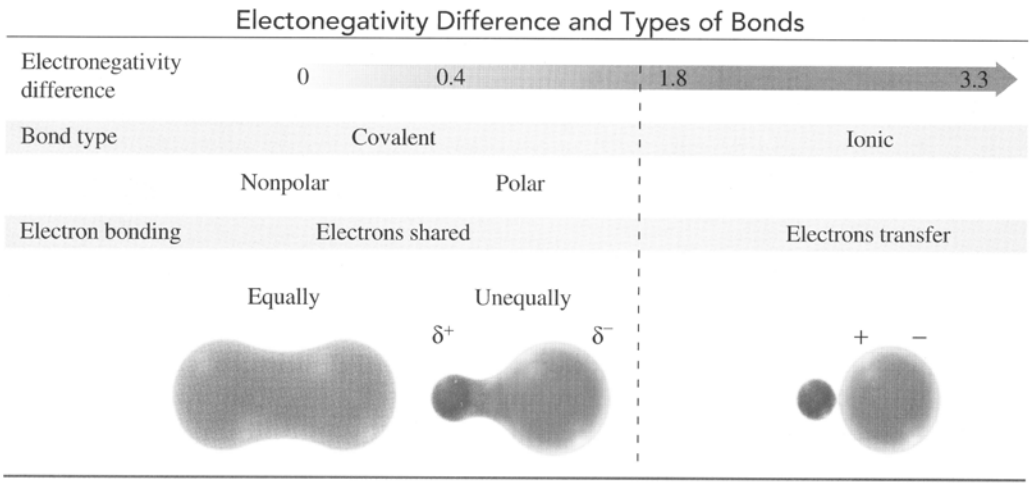
Electronegativity

Trends of Periodic Table

Group 1A (1)	Group 2A (2)
Li 1.0	Be 1.5
Na 0.9	Mg 1.2
K 0.8	Ca 1.0
Rb 0.8	Sr 1.0
Cs 0.7	Ba 0.9

Group 3A (13)	Group 4A (14)	Group 5A (15)	Group 6A (16)	Group 7A (17)	Group 8A (18)
H 2.1					
B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	
Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	
Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	
In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	
Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.1	

Electronegativity & Types of Bonds



Nonpolar Covalent Bond:

H-H F-F C_xH_y

Polar Covalent Bond

Indicate polarity of the following bonds using δ+/δ- or dipole moment arrows.

C-O C-Cl O-H

Arrange the following bonds in order of decreasing polarity?

C-O vs C-F vs C-N

Molecular Polarity - Depends on 2 factors

1)

2)

Nonpolar Molecule: no distribution of charge or a symmetrical (balanced) distribution of charge

Polar Molecule: an **asymmetrical** (unbalanced) distribution of charge

Examples:

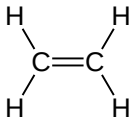
2 atom molecules

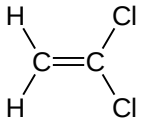
3 atom molecules

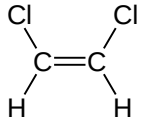
4 atom molecules

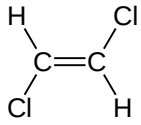
5 atom molecules

Polar or Nonpolar









Shapes & Interactions Part 3: Intermolecular Forces (IMFs)

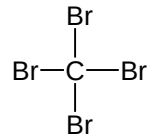
Intermolecular Forces =

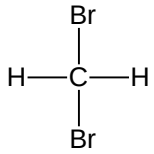
dipole-dipole:

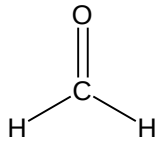
H-bonding:

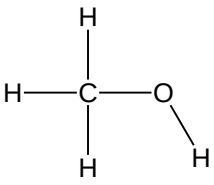
Relative Strengths of the IMFs

Determine the dominant IMF in each of the following compounds.



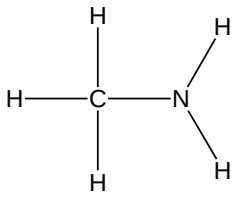




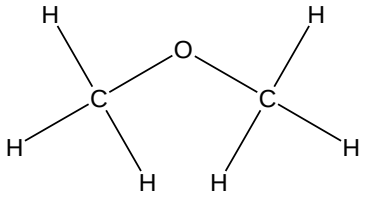


Are the following pure compounds capable of H-bonding?

a)

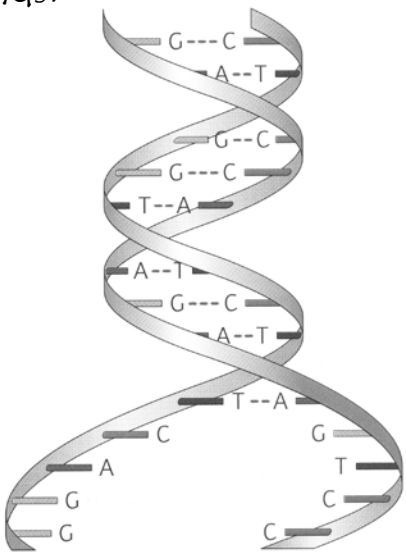


b)

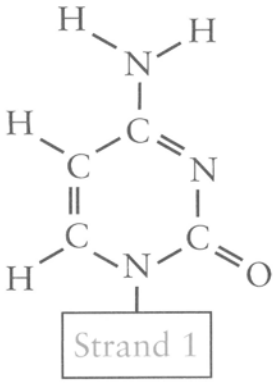


H-bonding in DNA

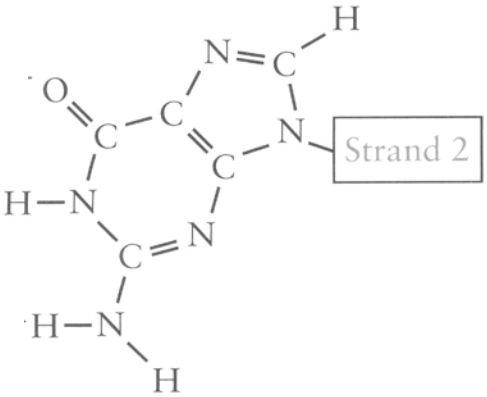
DNA has two strands bound together in the overall shape of a double helix. The two strands are held together by H-bonds formed between atoms on adjacent strands.



Use dashed lines to draw the H-bonds between C and G in the diagram below.



C

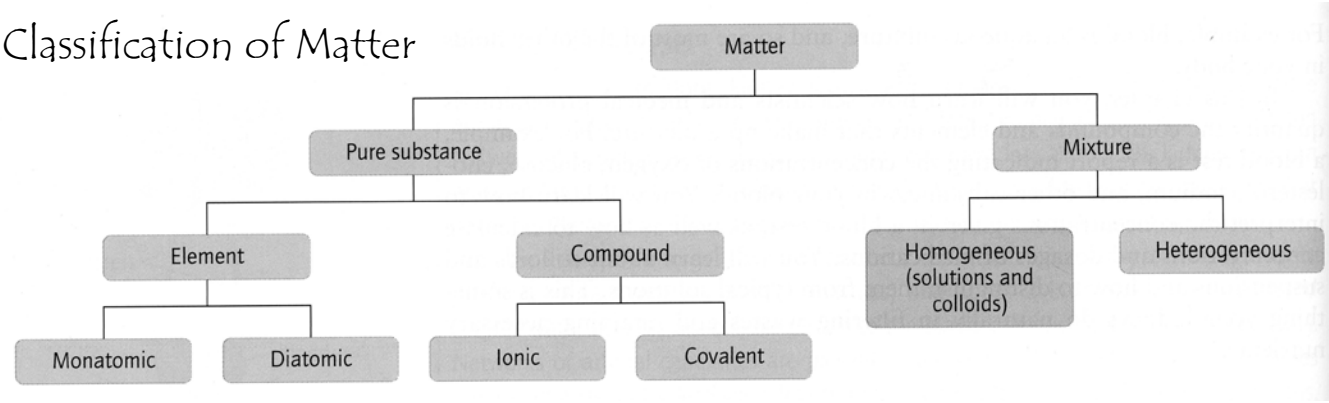


G

Shapes & Interactions Part 4:

IMFs and Solutions

Classification of Matter



Mixtures

Heterogeneous Mixture: components are unevenly distributed throughout the mixture

Homogeneous Mixture: components are evenly distributed throughout the mixture

Solutions

Solute: a substance present in the solution in a lesser amount

Solvent: the substance present in the greatest amount

Classify the following as

a) heterogeneous mixture
b) homogeneous mixture
c) compound
d) element.

____ A colorless gas, only part of which reacts with hot iron.

____ A cloudy liquid that separates into two layers upon standing.

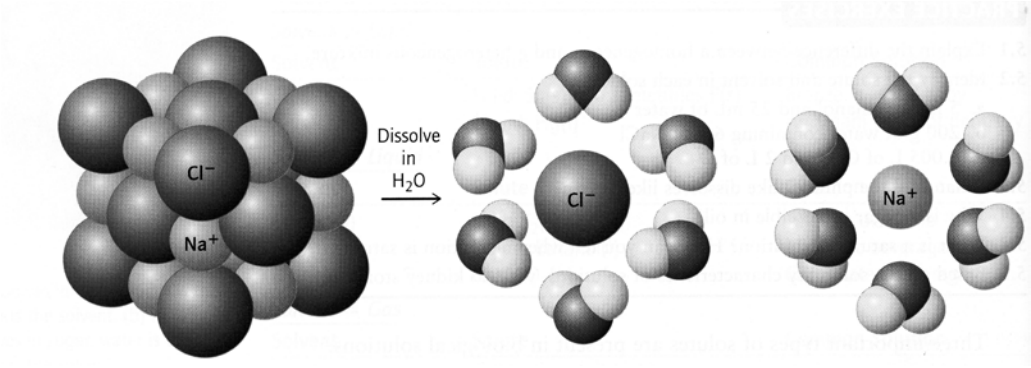
Solution Formation – IMF's between solute & solvent are comparable

Solubility Rules

Miscible =

Immiscible =

Ions as Solutes



Complete the reactions below when the following salts are dissolved in water.

a) $CaCl_{2(s)} \xrightarrow{H_2O}$

b) $Fe(NO_3)_{3(s)} \xrightarrow{H_2O}$

Molecules as Solutes

Gases as solutes

Molecules in the gas phase can also dissolve in water.

How does the solubility of gases and solids differ with temperature change?

Which cpd is more soluble in water?

$CH_3CH_2CH_2CH_2NH_2$ CH_3NH_2

Predict whether the following compounds are soluble in

W = water, O = octane (C_8H_{18}), or B= both.

a) ethanol (CH_3CH_2OH)

b) hexane (C_6H_{14})

c) vegetable oil

d) 1-octanol ($CH_3CH_2CH_2CH_2CH_2CH_2CH_2OH$)